

sary motions, so as to prove himself the GOVERNOR both of the natural and moral world ; tho' improv'd philosophy has given us a juster notion of these matters than the antients had. I wish our religious sentiments may advance, in proportion to our improved philosophy.

March 16, 1753.

Wm. Stukeley.

XXXIV. *A farther Account of the Giant's Causeway in the County of Antrim in Ireland, by the Rev. Richard Pocock, LL.D. Archdeacon of Dublin, and F. R. S.*

Read May 24, 1753. IN a letter, which I wrote in 1747 to Martin Folkes, Esq; President of the Royal Society, which was read in January, and printed in the *Philosophical Transactions* for that month, I observed, in relation to the Giant's Causeway, that there appeared in the Sea-cliffs three strata of pillars between thirty and forty feet high, with strata of a black rock between them ; that the causeway itself was the lowest of all these, extending in a point into the sea ; and that another is seen towards the top of the cliff.

Last summer I took another view of it ; I went from Bally-Castle, which is about 10 miles to the east of the Causeway. When I came two miles to the west of Bally-Castle, within less than a mile of Bal-lintoy, half a mile to the south of the sea-cliffs, and about a quarter to the south of the road, I saw the same

same kind of pillars in a low hill ; I observed both hexagons and pentagons.

The rocks towards the sea appeared as if they were formed in the same manner ; but when I came to them, I found it was only common rock in several strata, and perpendicular joints.

I went on about two miles to a peninsula called Donseverik, where I saw some tendency in the rock towards this work of nature ; and going about half a mile farther, came to the beginning of the pillars in the sea-cliff, as I believe, about five miles from the causeway : and the shore and cliffs being shap'd mostly in little semicircular bays, I had many very beautiful views of the upper and middle strata of pillars : in one, particularly, they had much of the appearance of ruin'd portico's one over the other ; and turning the little end of a spy-glass, it appeared something like the ruins of Palmyra, as a view of them is represented in a copper plate, published in the *Philosophical Transactions*.

This wonderful work of nature is continued on in the cliffs for about a quarter of a mile beyond the Giant's Causeway.

I saw it again in the road to Coleraine, five miles to the west of the Causeway, in a low hill a furlong to the south of the road, and two miles to the south of the sea. The pillars here are small ; and being about a mile and a half from Ballimagarry, where the earl of Antrim has a ruin'd house, lately burnt down, it serv'd, as I suppose, as a quarry for building part of that house, in which I saw a great number of the stones, and particularly one of nine sides. I saw others near two miles farther, to the south of

the road in a low hill, within two miles of Coleraine; so that the whole extends for about eleven Irish miles, or fourteen English.

Beyond Coleraine, to the east of Magilligan, I saw in the rocks towards the sea-cliffs, the stones in the rocks towards the sea-cliffs, the stones in the hills very regular, appearing at a distance much like these pillars. This is six computed miles beyond Coleraine, and consequently about ten English miles from the last pillars.

At Fairhead also, a high point of land, three miles to the east of Ballycastle, towards the top of it, the rock appears as in grand pillars. They say it is not in joints, but it has something of the appearance of a grand Gothic piece of workmanship.

As I spent a week at the Causeway, and sent away by sea to Dublin as great a variety of the stones as I could conveniently get, particularly a large octagon, with the eight large stones round it; a pair of lefs; with eight pair, that encompass it; two small pentagon pillars, about fourteen inches over, one of them three feet ten inches and a half high, the other five feet seven inches; one hexagon pillar, about the same size, and five feet five inches high; all which I have placed in my garden; so I have had an opportunity of considering it at leisure.

It is a black stone, weighty and brittle: and I have been informed, that it was tried in a glafs-house, and that it melted with kelp, so as to make the black glass bottles: which experiment, I have been told, was made by Mr. Dobbs of this kingdom, who is now in London.

Mr.

Mr. Drury, whom I shall have occasion to mention, found in a stone of the Causeway a rough pebble in the shape of an egg, about three quarters of an inch long, and above an inch thick; and when it was polish'd, it proved to be a white cornelian. They are from three fides to nine fides, frequently encompassed with as many stones as there are fides; but many of them have a narrow fide, which has no stone to it, but is filled up with a piece or pieces of stone, that shall be further explain'd; which pieces, when the stones are mov'd, commonly separate, and break off. Some stones have two, or three, or more, of these fides: so that it is possible, a stone, that has any number of stones round it, may have double the number of fides: tho' I saw none, that I had reason to think were of this kind, except some, that had probably only three stones round them; being hexagons, with three broad fides, and three very narrow fides.

Whatever the outward figure of the stone is, the concavity or convexity is either circular, or part of a circle; consequently, as the fides of the pillars are plain, the part between the inside circle and the outward figure must either be fill'd up (as it is seen) by stone, which sometimes separates, as mention'd above, and as will be further explain'd; or by the matter pressed up from the fides, as will be more plainly described. In the former case, when the end is convex, this stone often comes off all round at the joint, and leaves the convex end as part of a sphere, and the concave as a mould fitting to it.

I have some stones exactly like a hexagon cut in two, which might be part of a hexagon pillar split; for

for sometimes a whole pillar appears as split all the way down ; of which there is a remarkable one at the Causeway.

In relation to the joints in the pillars, this work of nature seems to be different from any thing yet known ; and it must be very difficult to assign any satisfactory causes of it.

I submit to the judgment of persons more experienced in these things what has occurred to me.

I suppose, for reasons, which I shall give, that the several parts of these pillars were at first formed either in the shape of a cylinder, with the upper end in a spherical figure, if not both ends ; or that they were either spherical or oblate spheroids.

For, being composed of crystal of six sides, and spar of three, and of a very fine black sand, it may be supposed, that, as the crystals and spars united, and formed an irregular body, the fine black sand fill'd up the interstices, and formed such cylindrical or spherical bodies, as yet soft ; but, in thin horizontal *laminæ* or plates like talc, as they mostly appear to be ; and, if great force is applied, the stones will separate in such plates between the joints ; and those parts of the pillars, which have been exposed to the weather, and corroded by it, appear in such plates. Sometimes indeed there are perpendicular joints ; as in the split pillar, there seems to have been such a one all down the pillar.

It is therefore probable, that, when this matter was in a fluid state, and when the stratum of rock was formed, on which it was made, the fluid contiguous to the rock still continued in motion ; that, after a time, some of the particles of matter, which compose

compose these pillars, being disengag'd from the particles of water, ceas'd to move, and form'd the parts of these pillars, which are next to the rock, in the above-mention'd figures; so much being formed only at once, or in a very short time, as extends to the first joint: that then, either by change of season, or some other accident, so much more water mixed with these particles, as prevented their continuing to form themselves into such a shape, and gave the former motion: that, afterwards, the decrease of the water might again be the cause of the former effect; and so on, till the intire pillars were formed; and the top of the last formed being convex, that, which was formed upon it, would probably be concave, and fit to it, either by its gravity, or by being softer.

All being as yet in some one or other of these figures, we suppose the gravitation of the second stratum above the first joint to operate in such a manner on that which was first formed, and still soft, as to press it down; and so eight stones being round one stone, would naturally press the middle stone into an octagon.

The reasons for concluding, that they were at first in some of these figures, are these:

That the concavity or convexity are either in an intire circle, or part of a circle:

That sometimes the ends of the stones appear to be of a spherical form for some space down, all round the stone; fill'd up only by a matter, that separates from it, as shall be further explain'd.

For it is to be observed, that the pillar is not always so press'd out, as in each stone to form a regular multangular figure; but sometimes there is a

narrow

narrow side, against which there is no stone, as observed before: sometimes it is pressed out only in part; and this, together with the spherical part, is fill'd up, probably at first with the floating matter; which, I suppose, when the other stone was formed upon it, so united with it, that it remains as a part of the other stone, and breaks off from it, when they are moved: and if this happened to the lower part of the upper stone, this matter, which fills up, might unite with the lower stone; for sometimes this narrow side is seen in the same stone both above and below, the angle being formed in the middle of the stone; and then it is filled up with the matter, which united with the stone above, and the stone below.

It is to be observed, in pursuance of the proof, that the stones were originally round and spherical at the ends; that when the pressure was not sufficient to make out the angles, which I suppose to be the cause of these narrow sides, it is in this case plainly seen, that the original circular shape of the stone is still retain'd; that side not being horizontally in a strait line, but appearing plainly to be part of a circle; as may be seen in the three pieces of stone, which I have sent, that separated from those sides, and fitted into them.

It appears also, that what has been press'd out beyond the circle at the ends is commonly flat, and not concave and convex; as it was probably made; not by the pressure at the ends on the spherical part, but by the pressure on the sides contiguous to it; and when part of the circle is taken off, in that case it is probable, that the pressure on the sides was very great.

In one stone, the matter, which only in part form'd the angle, force being applied to it, came off, and

left that part spherical, being one of those stones, in which one part of the same end is flat, and the other convex, swelling like a cushion.

This stone I sent as a single stone. It is a large octagon, twenty three inches over; but after it had been some time in my garden, I perceived a crack in it, and, applying force, it divided. The under stone had been so unequally press'd, that it is not only very thin on one side, but there is a large hole in it, about seven inches diameter, very near the edge of the stone; so that the matter must have been press'd away to the other side of the stone, not equally concave, and the stone above it must have press'd into the stone below this; in which lower stone the convex part, which press'd through the middle stone, must have been left, as it is broken: which I did not observe at the Causeway.

Some stones at the same end are partly concave, and partly convex; probably occasion'd by such an unequal pressure; so that I have one, which measures nine inches deep on one side, which is convex, and four and a half on the other, which is concave: another, tho' all convex, yet is six inches clear at one angle, and only four at the opposite angle; so that in these stones the joint appears as indented.

We are to suppose, that, generally, the top of the lower stones is convex, and the bottom, consequently, of the stone, that lies upon it, concave. But as sometimes both ends of a stone are concave, we must suppose, either that the lower part of the stone, which settled on it, was harder, or, being of equal hardness, by its gravitation press'd it down.

Since I left the Caufeway, I have been inform'd, that commonly, if the top of the stone in a pillar is found either concave or convex, the top likewise of every stone of that pillar is either concave or convex in the same manner ; which may be a subject for future observation.

It seems probable, therefore, that all the ends were originally spherical : some of the stones, it may be, exact spheres ; others, oblate spheroids ; and some longer stones in a cylindrical form, and of a spherical figure, at each end. To which conjecture I have been led, by observing the shape of some I have, and of two models of two stones represented in cork by Mr. Drury, who presented the prospects of the Causeway engraved to the Royal Society, from the drawings of his sister Mrs. Susanna Drury. One of these is convex at both ends ; and I have some in the same shape. This spherical figure has been altered by the pressure, in the manner I have observed : for, in the other model, part of the spherical figure is seen round the sides towards the concave end ; and I have one exactly of the same kind. In those also, which I have, that are at the same time partly convex and partly concave, the convex part seems to have been the natural figure of the stone, as before described : for, where both ends are concave, that, which was probably press'd by a harder stone form'd before it, is perfectly concave ; whereas that concavity, which is made by a stone probably form'd after it, is not so perfectly concave as the other ; but it commonly remains convex in some part, as observed before ; swelling out like a cushion press'd by any weight.

By

By all that I have been able to observe, the plates seem originally to have been horizontal: in some I have, which are convex, they are apparently so; and, as far as I could remark, in all, where the plates appear. Tho' it is probable, where the end of the end of the stone is concave, the laminæ or plates have in some measure been press'd in that form; tho' I could not certainly distinguish it in any of this kind.

Sometimes a joint near perpendicular begins as in a point from the side, and extends into that stone, and into all the stones of the pillar, which are beneath it; so as (when it has run the length of one stone) to take off either two sides of the stones or pillar, or one side, and part of two sides. This indeed sometimes happens to be in the middle of the pillar, and in the same manner all the way down, so as to form two distinct pillars. Thus I have some, which, by this means, have a side less at one end than at the other; and I have one, in which the spherical part takes off at one end two sides of the multangular figure, and makes part of a circle, as in some it takes off all the sides at one end; or, more properly, the stone remains in its original spherical figure. The pieces, which fill up where the stone is not press'd into a multangular figure, sometimes do not break off, as may be seen in the model.

Of the other models made by Mr. Drury, four of them fit to one another, and represent part of a pillar in the Causeway: The seven models not referr'd to, shew a variety of stones; the measures of all of them are marked in inches, and they are made by a scale of a tenth to an inch. The ends, which are cut smooth in the cork, or are marked with a pencil,

are such, as he could not see, or neglected to observe.

The fourth stone I have sent, which forms part of a circle, broke off from a stone flat at one end, is the spherical part of a stone, such as it appears towards the concave end of one already mention'd.

From these observations, those, who are well versed in natural philosophy, may possibly form some better judgment, and be more happy in their conjectures in relation to this difficult subject, the cause of the joints in the pillars of this extraordinary work of nature.

T A B. X.

Represents the plan and profile of the stones brought to Dublin by the Rev. Archdeacon Pococke.

Explanation of the Figures

Fig. 1. A plan of the pillar, with the measures of the lengths of the sides, *A, B, C, D*.

Fig. 2. A plan of the pillar, with the lengths of the other four sides; *viz. E, F, G, H*, and the distances of the circle from the sides of the polygon.

Fig. 3. A profile of the stones, shewing the sides *A, B, C, D*.

Fig. 4. A profile shewing the sides *E, F, G, H*.

The black lines shew the deviation of the circles from a plane: and the large prick'd waved lines shew the profile of the swelling and concavity within them.

The upper row of figures in each stone shews the heights of the sides at the angles so far as they are strait.

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Fig. 1.

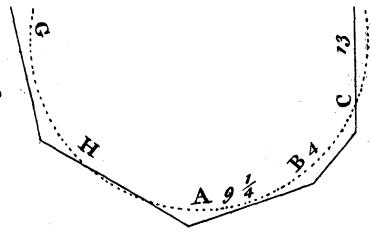
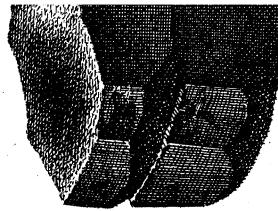


Fig. 5.



The under row of figures shews the remainder of the height of the stone at that angle ; or it is the height of the angular curved pieces, which, before they fell off, were the complements filling up the prism, and making the sides of the pillar wholly flat, and the edges or angles of the pillar all strait lines.

Fig. 5. Two upper stones of a pillar, as they stood on the Causeway, shewing 4 sides of the pillar. Diameter of the upper circle of the upper stone 22 inches.

The circle is about half an inch within the polygon at the side *D* ; but is cut off by the side *C*, about three quarters of an inch.

The sides *B* and *b* a little broken.

Fig. 6. The two stones turned together upside-down ; shewing the other four sides of the pillar.

Diameter of the (now) uppermost circle about twenty-one inches.

The side *H* much broken. Angle *f*, rounded off from the circle to the (now) lower end of the stone. Angle *G* is not rounded off.

Fig. 7. The two stones separated a little to shew the bottom of the upper stone, and top of the under one.

Diameter of the circles, which meet twenty-two inches.

The convex part of the bottom of the upper stone fitting the concave part of the top of the under one ; and the concave part of the bottom of the upper stone fitting the convex part of the top of the under stone.